Claims

[c1] 1. A method of designing a magnetic resonance imaging magnet including an axial imaging bore to receive patients, comprising the steps of:
(a) providing at least one correction coil positioned about said axial bore; and
(b) using the correction coil to reduce lower order harmonics generated by the magnet to improve homogeneity of the magnetic field at selected volumes around the magnet.

[c2] 2. The method according to claim 1 wherein the magnet is a superconducting magnet.

[c3] 3. The method according to claim 1 wherein the correction coil comprises a shimming coil used to improve homogeneity of the magnetic field after construction of the magnet.

[c4] 4. The method according to claim 1 wherein the improved magnetic field has a design peak-to-peak magnetic field inhomogeneity of less than 10 parts per million in a cylindrical, a spherical or an elliptical imaging volume between 20 to 50 cm. in diameter.

[c5] 5. The method according to claim 1 wherein the magnet comprises at least six main magnet coils.

[c6] 6. The method according to claim 1 wherein the magnet has a longitudinal axis disposed to lie in a horizontal plane or a vertical plane.

[c7] 7. The method according to claim 1 wherein the magnet has a field strength of 0.5-3.0 Tesla.

[c8] 8. A method of designing a superconducting magnetic resonance imaging magnet including an axial imaging bore to receive patients, comprising the steps of:
(a) providing at least one set of correction coils positioned about, and spaced along, said axial bore; and
(b) using the set of correction coils to reduce first and second order harmonics generated by the magnet to improve homogeneity of the magnetic field at more than one selected volume around the magnet.

[c9] 9. The method according to claim 8 wherein the set of correction coils comprise shimming coils used to improve homogeneity of the magnetic field after construction of the magnet.

[c10] 10. The method according to claim 8 wherein the magnetic field has a design peak-to-peak magnetic field inhomogeneity of less than 10 parts per million in a cylindrical, a spherical or an elliptical imaging volume between 20 to 50 cm. in diameter.

[c11] 11. The method according to claim 8 wherein the magnet comprises at least six main magnet coils.

[c12] 12. The method according to claim 8 wherein the magnet has a longitudinal axis disposed to lie in a horizontal plane or a vertical plane.

[c13] 13. The method according to claim 8 wherein the magnet has a field strength of 0.5-3.0 Tesla.

[c14]

14. A method of designing a magnetic resonance imaging magnet including an axial imaging bore to receive patients, main magnet and bucking coils positioned at selected locations adjacent said axial bore and at least one correction coil positioned about said axial bore, said method comprising the steps of:
(a) determining information concerning the magnet to be designed including a desired peak-to-peak magnetic field value of the magnet;
(b) measuring the field strength in the bore of the magnet at a predetermined number of points within a measurement volume comprising a large image volume and a small image volume;
(c) determining the field inhomogeneity of the measurement volume by comparing the peak-to-peak field measured between the highest and lowest values of all the measured points to the desired peak-to-peak magnetic field value;
(d) adjusting the locations of the main and bucking coils to lower the peak-to-peak field throughout the measurement volume;
(e) adjusting the currents in the correction coil to adjust lower order harmonics in the small image volume; and
(f) repeating steps (c), (d) and (e) until the field inhomogeneity of the measurement

volume is less than or equal to the desired peak-to-peak magnetic field volume.

[c15] 15. A method of designing a magnetic resonance imaging magnet including an axial imaging bore to receive patients, main magnet and bucking coils positioned at selected locations adjacent said axial bore, and at least one correction coil positioned about said axial bore, said magnet having a longitudinal axis disposed to lie in a horizontal plane, said method comprising the steps of:
(a) determining information concerning the magnet to be designed selected from the group consisting of the number of coils, the positions of the coils, the number of windings per coil, the direction of current for each coil and the length of the magnet, said information including a desired peak-to-peak magnetic field value of the magnet;
(b) measuring the field strength in the bore of the magnet at a predetermined number of points within a measurement volume comprising a large image volume and a small image volume;
(c) determining the field inhomogeneity of the measurement volume by comparing the peak-to-peak field measured between the highest and lowest values of all the measured points to the desired peak-to-peak magnetic field value;
(d) adjusting the locations of the main and bucking coils to lower the peak-to-peak field throughout the measurement volume;
(e) repeating step (c);
(f) adjusting the currents in the correction coil to adjust lower order harmonics in the small image volume; and
(g) repeating steps (c) and (f) until the field inhomogeneity of the measurement volume is less than or equal to the desired peak-to-peak magnetic field value.

[c16] 16. A method of designing a superconducting magnetic resonance imaging magnet including an axial imaging bore to receive patients, main magnet and bucking coils positioned at selected locations adjacent said axial bore and at least one set of correction coils positioned about and spaced along said axial bore, said method comprising the steps of:
(a) determining information concerning the magnet to be designed including a desired peak-to-peak magnetic field value of the magnet;
(b) measuring the field strength in the bore of the magnet at a

predetermined number of points within a measurement volume comprising a large image volume and a small image volume;
(c) determining the field inhomogeneity of the measurement volume by comparing the peak-to-peak field measured between the highest and lowest values of all the measured points to the desired peak-to-peak magnetic field value;
(d) adjusting the locations of the main and bucking coils to lower the peak-to-peak field throughout the measurement volume;
(e) adjusting the currents in the correction coils to adjust lower order harmonics in the small image volume; and
(f) repeating steps (c), (d) and (e) until the field inhomogeneity of the measurement volume is less than or equal to the desired peak-to-peak magnetic field volume.

[c17]

17. A method of designing a superconducting magnetic resonance imaging magnet including an axial imaging bore to receive patients, main magnet and bucking coils positioned at selected locations adjacent said axial bore, and at least one set of correction coils positioned about and spaced along said axial bore, said magnet having a longitudinal axis disposed to lie in a horizontal plane, said method comprising the steps of:
(a) determining information concerning the magnet to be designed selected from the group consisting of the number of coils, the positions of the coils, the number of windings per coil, the direction of current for each coil and the length of the magnet, said information including a desired peak-to-peak magnetic field value of the magnet;
(b) measuring the field strength in the bore of the magnet at a predetermined number of points within a measurement volume comprising a large image volume and a small image volume;
(c) determining the field inhomogeneity of the measurement volume by comparing the peak-to-peak field measured between the highest and lowest values of all the measured points to the desired peak-to-peak magnetic field value;
(d) adjusting the locations of the main and bucking coils to lower the peak-

to-peak field throughout the measurement volume;

(e) repeating step (c);

(f) adjusting the currents in the correction coils to adjust lower order harmonics in the small image volume; and

(g) repeating steps (c) and (f) until the field inhomogeneity of the measurement volume is less than or equal to the desired peak-to-peak magnetic field value.